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Risk of cesarean wound complications in diabetic gestations

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KEY WORDS
Wound complications
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Objective: This study was undertaken to examine the association between pregestational diabetes mellitus (DM) and wound complications after cesarean delivery (CD).
Study design: This was a retrospective, observational cohort study in patients with type 1 and 2 DM compared with non-DM controls undergoing CD. Wound complications were defined as wound infection, wound separation greater than 1 cm, and wound dehiscence.
Results: There was an overall incidence of wound complications of 18.4% (34/185) in DM versus 5.8% (10/174) in non-DM (unadjusted odds ratio of 3.7; 95% CI = 1.8-7.7). Mean body mass index before pregnancy was 30.9 in DM versus 26.5 kg/m^2 in non-DM ($P < .01$). A multivariable logistic regression model adjusting for body mass index, length of surgery, and previous CD demonstrated a 2.5-fold increased risk of wound complications in DM patients compared with non-DM patients (95% CI = 1.1-5.5).
Conclusion: Pregestational diabetes is associated with a 2.5-fold increase in wound complications after CD.

Patients with pregestational diabetes are at increased risk of complications in pregnancy, including miscarriage, fetal anomalies, fetal growth abnormalities, intrauterine fetal demise, gestational hypertension, preeclampsia, birth injury, and operative delivery.[1] Poor wound healing after surgery is often associated with diabetes independent of pregnancy. Other risk factors generally cited for poor wound healing include obesity, hypoxemia, malnutrition, anemia, immunosuppressive medications, longer surgery, and chronic medical illness. The risks of wound infection and complications after cesarean delivery (CD) in diabetic gravid women are not well defined.

Wound complications are higher in diabetic patients in the general surgery and cardiothoracic literature, but little data exist regarding the incidence in gravid patients undergoing CD.[2-4] The mechanism for increased postoperative infections may relate to high-serum glucose inhibiting the immune response needed for fighting bacterial and fungal infections.[5] Diamond et al[6] demonstrated a 4- to 5-fold increased risk of wound infection or endometritis in diabetic patients after elective and nonelective CD. In their study, patients did not receive prophylactic antibiotics, and results prompted the

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Table I Patient characteristics

	DM (n = 192)	Non-DM (n = 175)	*P* value
Maternal age (y)	29.6	29.8	.62*
GA at delivery (wks)	37.2	38.5	.01*,†
Parity-nulliparous	43%	37%	.19‡
Insurance (Medicaid)	58%	39%	.01†,‡
Smoker	16%	17%	.87‡
BMI (m^2/kg)	30.9	26.5	.01*,†
Obesity	70%	49%	<.01†,‡
GBS positive	43%	18%	<.01†,‡
STDs during pregnancy	2%	1%	.87§

GBS, Group B *Streptococcus*; *STDs,* sexually transmitted diseases.
* *t* test.
† $P < .05$.
‡ χ^2 test.
§ Fisher exact test.

recommendation that antibiotics be routinely provided to all diabetic patients undergoing CD. Subsequently, Riley et al[7] examined CD after labor or rupture of the membranes in patients with diabetes and found no difference in postoperative infections compared with a control low-risk population. The majority of both diabetic and control patients received prophylactic antibiotics. However, the study was likely underpowered to detect an existent difference between the diabetic and control groups. Therefore, current evidence is inconclusive as to the risk of wound complications in pregestational diabetic patients undergoing CD.

Our hypothesis is that wound complications after CD are higher in patients with pregestational diabetes when compared with patients without diabetes. This study examined the association between pregestational diabetes and wound complications after labor and nonlabor CD. Secondary aims of the study were to evaluate the hospital length of stay, incidence of chorioamnionitis and endometritis, and readmission rates in both diabetics and nondiabetic patients.

Material and methods

This was a retrospective, observational cohort study in a series of patients with pregestational diabetes mellitus (DM) compared with nondiabetic patients undergoing CD for all indications. Between January 1995 and January 2003, all patients delivered by cesarean section at Women and Infants Hospital with either type 1 or 2 diabetes were identified through our diabetes database. Type 1 diabetes was defined as insulin-dependent diabetes in patients caused by chronic autoimmune disease, and type 2 diabetes was defined as noninsulin-dependent diabetes, both in patients diagnosed before conception. Classification of patients was based on medical information from the first prenatal visit that was reviewed and recorded on the basis of these definitions. Control patients were the next nondiabetic patient operatively delivered from birth log entries. Approval for the study was obtained from the Institutional Review Board.

Medical charts were reviewed for maternal data such as age, gravidity, parity, body mass index (BMI), smoking status, insurance status, hemoglobin A1c (HgAlc) before 20 weeks' gestation (in DM only), medical diseases, surgical histories, and years of diabetes. Antepartum and postpartum data abstracted include gestational age at delivery, group B *Streptococcus* (GBS) status, sexually transmitted diseases during pregnancy, indication for CD, labor characteristics such as length of labor and rupture of membranes, number of vaginal examinations in labor, use of intrauterine pressure catheter and fetal scalp electrode, diagnosis of chorioamnionitis, skin incision, uterine incision, surgical technique, antibiotic usage (type of antibiotics, timing of antibiotics before or after delivery, and duration of antibiotics), hemoglobin before and after delivery, estimated blood loss (EBL), presence of meconium, postpartum hemorrhage, postpartum glycemic control, hospital length of stay, endometritis, and readmission rates. Prophylactic antibiotic usage was typically cefazolin or clindamycin after cord clamp. Postpartum emergency room visits as well as routine postpartum visit records were reviewed to include any wound complications not noted during the index admission.

The multidisciplinary Diabetes in Pregnancy Program at Women and Infants Hospital managed all diabetic patients with insulin (split-mixed subcutaneous injections) or insulin pumps. Blood sugar goals were less than 100 mg/dL fasting and less than 120 mg/dL 2-hours postprandial. Checking patient logs with glucometers at each prenatal visit reinforced patient compliance. HgA1cs were routinely obtained at the first prenatal visit but were not followed throughout gestation.

A variety of private and faculty obstetricians managed control patients. Patients undergoing elective (eg, repeat, breech, or macrosomia) as well as nonelective (arrest of dilation or descent, nonreassuring fetal status, bleeding) CD between 1995 and 2003 were included in the analyses. All patients with gestational DM were excluded.

Chorioamnionitis was defined as an intrapartum fever of higher than 100.4°F, and fetal and maternal tachycardia treated with antibiotics. Wound complications included wound infection, separation, and dehiscence. Wound infection was defined as cellulitis of the skin or subcutaneous tissue or purulence requiring drainage with fever higher than 100.4°F. Wound separations, spontaneous and induced, caused by wound seromas were only included if greater than 1 cm. Wound dehiscence was defined as a breakdown of the approximated fascia. Postpartum endometritis was defined as

Table II Descriptive data

	DM (n = 192)	Non-DM (n = 175)	*P* value
Prior abdominal surgery	48%	50%	.72*
Repeat CD	44%	42%	.69*
Labor before CD	55%	55%	.97*
Length of labor before CD (h)	10.9	10.1	.42
Length of rupture of membranes (h)	22.6	17.0	.49
Indication for CD arrest disorder	23%	26%	.96
Elective delivery	35%	34%	.96
Nonreassuring fetal tracing	21%	20%	.96
Other (previa, macrosomia, abruption, HSV, breech)	21%	20%	.96
Skin incision—horizontal	97%	99%	.29†
Uterine incision—low transverse	93%	95%	.36†
Number of vaginal examinations	3.2	2.7	.17†
Fetal scalp electrode use	50%	58%	.24*
Intrauterine pressure catheter use	65%	64%	.86*
Anemia (Hgb <10%g/dL)	41%	42%	.88*
Blood transfusion	4%	1%	.11†
EBL (mL)	781 ± 27	642 ± 19	< .01‡,§
Postpartum hemorrhage	12%	6%	.05*,‡
Meconium	10%	19%	.01*,‡
Time in operating room (min)	58.7	42.6	.01‡,§
Chart review postpartum (wks)	3.8 ± 0.2	1.7 ± 0.2	.01‡,§,‖
HgA1c (DM only)	8.1%	N/A	
Postpartum glucose >200 mg/dL (DM only)	13.5%	N/A	
Prophylactic antibiotics	55.7%	58.9%	.55*

HSV, Herpes simplex virus.
* χ^2 test.
† Fisher exact test.
‡ $P < .05$.
§ *t* test.
‖ Standard error.

fever higher than 100.4°F, fundal tenderness or foul-smelling lochia with no other source of fever requiring more than 24 hours of antibiotics. Anemia was defined as a hemoglobin of less than 10 g/dL. Obesity was defined as a BMI of greater than 26 kg/m^2. Postpartum hemorrhage was defined as EBL greater than 1000 mL or need for postoperative blood transfusion. Typical hospital length of stay is 4 days after CD.

Data were analyzed with the use of Student *t* tests, χ^2 analysis, Fisher exact test and a multivariable logistic regression model. *P* values of less than 0.05 were considered statistically significant.

Table III Medical complications

	DM (n = 192)	Non-DM (n = 175)	*P* value
Retinopathy and/ or nephropathy	6.3% (12)	0	<.01*,†
Chronic hypertension	17.7% (34)	4.6% (8)	<.01*,‡
Vascular disease	1% (2)	0	.5†
Cardiac disease	0.5% (1)	1.1% (2)	.61†
Pulmonary disease	17.2% (33)	14.3% (25)	.45‡

* $P < .05$.
† Fisher exact test.
‡ χ^2 test.

Results

Medical records from 199 diabetic and 199 nondiabetic patients were reviewed. A total of 7 diabetic patients and 24 nondiabetic patients were excluded from the analyses secondary to medical record unavailability for review or the diagnosis of gestational DM. Denominators reported are based on available information in the medical record; all records were not complete in all data abstracted. Patient characteristics and descriptive data are shown in Tables I and II. The average length of time of diabetes before pregnancy was 9.9 ± 8.5 years. Forty-seven percent of patients had type 1 diabetes and 53% of patients had type 2 diabetes. Medical complications in DM and controls are noted in Table III. There was more retinopathy, nephropathy, and chronic hypertension in DM patients versus controls. There were no differences in maternal age, parity, previous abdominal surgery, smoking status, cesarean

Table IV Wound complications

	DM	Non-DM	Unadjusted OR (95% CI)
WI	13% (24/186)	5% (9/175)	2.7 (1.2-6.1)*
WS	10% (18/185)	2% (3/174)	6.1 (1.8-21.2)*
Both WI and WS	4.3% (8/185)	1.2% (2/174)	3.9 (0.8-18.6)
Wound dehiscence	0	0	N/A
Wound complications†	18.4% (34/185)	5.8% (10/174)	3.7 (1.8-7.7)*

WI, Wound infection; *WS,* wound separation.
* $P < .05$.
† Wound complications = WI + WS − both WI and WS.

Table V Secondary outcomes

	DM (n = 192)	Non-DM (n = 175)	RR (95% CI)
Hospital LOS >4 d (n = 49)	17% (31)	10% (18)	1.6 (0.9-2.8)
Chorioamnionitis (n = 29)	6% (12)	10% (17)	0.6 (0.3-1.3)
Endometritis (n = 24)	6% (11)	8% (13)	0.8 (0.4-1.7)
Readmission status (n = 8)	3% (6)	1% (2)	2.8 (0.6-13.8)
Total (n = 86)	28% (49)	22% (37)	1.3 (0.9-1.8)

LOS, Length of stay.

surgical technique, use of prophylactic antibiotics, labor characteristics, anemia, or need for blood transfusion. EBL, although higher in DM patients, was a subjective estimate and not reflected by the percentage of anemia or rate of transfusion between groups. BMI before pregnancy was significantly greater in DM patients compared with control patients (30.9 kg/m^2 vs 26.5 kg/m^2, $P < .01$).

Wound complications are listed in Table IV. The incidence of wound infection was 13% (24/186) in DM and 5% (9/175) in control patients for an unadjusted odds ratio [OR] of 2.7 (95% CI, 1.2-6.1, $P < .05$). There was an overall incidence of wound complications of 18.4% (34/185) in DM and 5.8% (10/174) in control patients for an unadjusted OR 3.7 (95% CI, 1.8-7.7, $P < .05$). A multivariable model adjusting for BMI, length of surgery, and previous CD demonstrated a 2.5-fold increased risk of wound complications in DM compared with control patients (95% CI, 1.1-5.5, $P < .05$). Differences in wound complications were not attributable to patient insurance status, prophylactic antibiotics, or glycemic control. Patients with wound infections had private insurance (12%) or Medicaid (13%, relative risk [RR] 1.1, 95% CI 0.6-1.9). Patients with wound infections had prophylactic antibiotics in 8.6% (18/209) and no prophylactic antibiotics in 9.9% (15/152) of cases for a RR of 0.9 (95% CI 0.4-1.8). Glycemic control was similar in diabetics with and without wound complications (HgA1c was 7.9% vs 8.1% respectively, RR 0.9, 95% CI 0.8-1.2 and postpartum glucose >200 mg/dL was 19% vs 16%, RR 0.8, 95% CI 0.4-1.6). Similar numbers of patients received prophylactic antibiotics in each group (Table II, 55.7% in diabetics and 58.9% in nondiabetics, $P = .55$). Wound closure was different between groups, with 80% (140/174) of control patients and 97% (183/188) of DM patients having staple closure ($P < .01$ by χ^2 analysis). The remainder of patients had an absorbable subcuticular suture used for wound closure. When controlling for staples, DM patients were at increased risk of wound complications than control patients as the OR increased from 3.7 to 4.3. Intraoperative drain placement was used in 0.6% (1/174) control patients and 5.3% (10/188) DM patients ($P = .01$ by Fisher exact test). Adding drain usage to the multivariable model did not change the estimate of effect and therefore it was not considered a confounder (OR went from 3.7 to 3.45, a 6% difference). Subcutaneous tissue closure (for tissue depth >2 cm) was used in 18.1% (34/188) DM versus 12.6% (22/174) control patients ($P = .15$).

Secondary outcomes were not different as listed in Table V. There was no difference in hospital length of stay, rates of chorioamnionitis/endometritis, or readmission between the 2 groups.

A subanalysis of the data in only laboring patients before CD did not reveal that antibiotic prophylaxis was protective for wound complications. Among all patients who labored, diabetic patients were 1.9 times as likely to develop wound complications than controls regardless of prophylactic antibiotic use in a multivariable logistic regression model (95% CI, 0.7-5.3, P value NS).

Comment

This study supports the clinical observation that pregestational DM is a risk factor for wound complications after CD independent of prophylactic antibiotics, obesity, length of surgery, or history of abdominal surgery. The secondary outcomes, hospital length of stay, chorioamnionitis and endometritis, and readmission rates were not different, despite an increase in wound complications in DM. This may be attributable to a long initial hospital stay in cesarean patients and frequent use of outpatient services such as visiting nurses and office visits.

Limitations of our study include its retrospective design. Despite this limitation, chart reviews included outpatient visits. It remains possible that more wound complications were not detected in the control group, as not all postpartum charts could be obtained (Table II, chart review postpartum showed 3.8 vs 1.7 weeks $\pm$ 0.2 follow-up in DM vs control). Longer follow-up postpartum chart reviews for DM patients could, in part, explain the increased wound complication rate in this population. However, most wound complications were noted in the index hospital admission in both groups. Other limitations include the lack of HgA1c values near the time of delivery, reflecting glycemic control in the weeks just before surgery. Postpartum glucose values and the single HgA1c obtained at registration for care were used as indices of glycemic control but may not appropriately reflect glycemic control near term.

Another limitation to the study is that the same attending physicians did not manage all patients. Despite this disparity, the use of antibiotics was similar suggesting that hospital practices are not dramatically different between responsible physicians. Women and Infants Hospital is also a large teaching hospital and residents are involved in all surgical deliveries.

Regarding wound closure technique, although staples were used more frequently in DM than control patients, the subcutaneous space was closed in similar numbers of patients in each group. Staple closure has not been shown to be associated with increased risk of wound complications.[8] At our institution, it is a practice pattern to use staple closure in DM patients, but the difference in closure techniques did not explain the difference in incidence of wound complications between the 2 groups. In addition, as the frequency of subcutaneous tissue closure was similar between groups, this did not explain the difference in wound complications as closure of subcutaneous tissue greater than 2 cm in depth has been shown to decrease the incidence wound seromas.[9]

Strengths of our study include adequate power to demonstrate a difference between groups. Cases and controls were matched by day of delivery to decrease temporal variations in practice during the 8-year span of chart reviews. In addition, other risk factors for wound infections such as obesity, labor characteristics, maternal anemia, wound closure techniques, and socioeconomic status were either similar in each group or accounted for in the multivariable logistic regression analysis.[10] These risk factors did not explain the increased risk of wound complications in DM patients. The cause of poor wound healing in DM patients is unclear but may be a consequence of vasculopathy with subsequent poor tissue perfusion, neuropathy with decreased awareness of tissue damage, or decreased immune function with subsequent white blood cell dysfunction.[5]

Finally, our study was not designed to evaluate the benefit of prophylactic antibiotic usage in our population, either in elective or nonelective CD. Although the results of this study do not support a reduction of wound complications with antibiotic usage after CD, inadequate power in the subanalyses may be the explanation. The study did not have sufficient power to assess wound complications after CD in laboring patients and this likely explains why the subanalysis did not reach statistical significance. In the literature, it is unclear whether prophylactic antibiotics decrease wound infection in low-risk CD patients without labor or ruptured membranes but may have more benefit in higher-risk patients such as those with labor, ruptured membranes, longer surgery times, or higher baseline risks.[11] Therefore, consideration should be given to providing prophylactic antibiotics to DM patients for CD in an effort to reduce wound complications. Additional potential interventions to decrease the high wound complication rate in DM patients warrant investigation.

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